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NASA-15510 (June 2004)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA

Superseding NASA-15510 (December 2003)

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SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15510

BOILERS

06/04

-- End of Section Table of Contents --

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SECTION 15510

BOILERS
06/04

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NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers hot water boilers for heating office buildings and other plants where heating with hot water is an acceptable method. Select, revise, and delete to suit project.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: The following references should not be manually edited except to add new references. References not used in the text will automatically be deleted from this section of the project specification.

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The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13	(2000) Gas-Fired Low-Pressure Steam and Hot Water Boilers

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 51	(1999) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
ASHRAE-Hdbk SE-SI	(2000) Handbook, HVAC Systems and Equipment (SI Edition)

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IV	(2001) Boiler and Pressure Vessel Code; Section IV, Recommended Rules for the Care and Operation of Heating Boilers

CSA INTERNATIONAL (CSA)

CSA Directory	Canadian Standard Associations Certified Product Listings

U.S. DEPARTMENT OF DEFENSE (DOD)

MS MIL-B-17452	(1998e) Boilers, Steam and Hot Water, Firetube, Scotch Packaged Type
MS MIL-B-18796	(1998f) Burners, Single: Oil, Gas, and Gas-Oil Combination for Packaged Boilers

U.S. DEPARTMENT OF ENERGY (DOE)

DOE CE-5	(2000) How to Buy an Energy-Efficient Commercial Boiler

UNDERWRITERS LABORATORIES (UL)

UL 834	(1998) UL Standard for Safety Heating, Water Supply and Power Boilers - Electric

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.
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The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

The following shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

Material, Equipment, and Fixture Lists
Construction Equipment List
Existing Conditions

Listing of Product Installation shall be submitted for boiler units in accordance with paragraph entitled, "Installation," of this section.

SD-02 Shop Drawings

The following shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

Piping Materials
Valves
Gages
Controls

Fabrication drawings shall be submitted for the following items:

Cast Iron Boilers
Watertube Boilers
Steel Boilers
Gas-Burning Equipment
Boiler Trim and Accessories

The following shall be submitted for boilers in accordance with paragraph entitled, "General Requirements," of this section.

Installation Drawings
As-Built Drawings

SD-03 Product Data

Equipment foundation data shall be submitted for the following items including equipment weight and operating loads, location and projection of anchor bolts, and horizontal and vertical clearances for installation, operation, and maintenance. Data shall also include dimensions of foundations and relative elevations, and installation requirements such as noise abatement, vibration isolation, and utility services.

Cast Iron Boilers
Watertube Boilers
Firetube Boilers
Steel Boilers
Gas-Burning Equipment

Equipment and performance data shall be submitted for the following items indicating use life, system functional flows, safety features, and other features such as electrical system protective device ratings.

Cast Iron Sectional Boiler
Firetube Boilers
Watertube Boilers
Steel Boilers
Gas-Burning Equipment
Combustion Safety Controls
Combustion Controls

Manufacturer's catalog data shall be submitted for the following items:

Cast Iron Boilers
Watertube Boilers
Firetube Boilers
Steel Boilers
Gas-Burning Equipment
Combustion Controls
Boiler Trim and Accessories
Combustion Safety Controls

Spare Parts

SD-04 Samples

Manufacturer's Standard Color Chart shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-05 Design Data

Design Analysis and Calculations shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-06 Test Reports

Test reports shall be submitted showing hydrostatic test results of boilers in accordance with the paragraph entitled, "Field Tests," of this section.

SD-07 Certificates

Certificates shall be submitted for boilers in accordance with paragraph entitled, "General Requirements," of this section.

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted in accordance with paragraph entitled, "Installation," of this section.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section.

1.3 GENERAL REQUIREMENTS

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NOTE: If Section 15003 GENERAL MECHANICAL PROVISIONS is not included in the project specification, applicable requirements therefrom should be inserted and paragraph one deleted. If section 16225 MOTORS is not included in the project specification, applicable requirements therefrom should be inserted and paragraph two deleted.
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Section 15003 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

[Section 16225 MOTORS applies to this section.]

Design Analysis and Calculations shall be submitted for boilers including input and gross output ratings.

Material, Equipment, and Fixture Lists shall be submitted for boiler systems including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Construction Equipment List shall include a list of proposed equipment to be used in performance of construction work.

Results of Contractors survey of Existing Conditions shall include features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

Installation Drawings shall be submitted for boilers in accordance with the manufacturer's recommendations. Drawings shall include details of equipment room layout and design.

As-Built Drawings shall be submitted for boilers providing current factual information including deviations from, and amendments to, the drawings and concealed and visible changes in the work.

Connection diagrams shall be submitted indicating the relations and connections of Piping Materials, Valves, Gages and Controls. Drawings shall indicate the general physical layout of all controls, and internal tubing and wiring details.

Manufacturer's Standard Color Chart shall indicate the manufacturer's standard color selections and finishes for boilers.

Certificates shall be submitted for boilers showing results of factory tests performed at the manufacturer's plant.

PART 2 PRODUCTS

Boilers shall have efficiencies in accordance with the recommended levels specified in DOE CE-5.

2.1 CAST IRON SECTIONAL BOILER

Boiler shall be of the self-contained, cast iron sectional, package type, complete with accessories, and field erected or mounted on a steel base. Each unit shall include the boiler, gas-burning equipment, boiler fittings, automatic controls, forced- or induced-draft fan, insulation, electric wiring, integral piping, and protective housing. Boiler shall be constructed in accordance with the provisions of ASHRAE-Hdbk SE-SI, Chapter 28, UL 834 and ASME BPVC SEC IV (Boiler and Pressure Vessel Code) and shall be stamped with the official ASME symbol. Boiler shall be certified, tested and shall have CSA-certified input and gross output ratings.

2.2 FIRETUBE BOILERS

Boiler shall be of the self-contained, multipass, package type, complete with accessories, mounted on a structural-steel base. Each unit shall include the boiler, gas-burning equipment, boiler fittings, automatic controls, forced- or induced-draft fan, insulation, electric wiring, integral piping, and protective housing. Boiler shall be a horizontal, tubular, Scotch marine type, constructed in accordance with ASHRAE-Hdbk SE-SI, Chapter 28, UL 834 and ASME BPVC SEC IV. Complete unit shall conform to ASHRAE-Hdbk SE-SI, Chapter 28, UL 834 and MS MIL-B-17452, Class I (standard duty), as modified herein.

2.3 WATERTUBE BOILERS

Boiler shall be of the self-contained, package-type, complete with

accessories, mounted on a structural-steel base. Each unit shall include the boiler, gas-burning equipment, boiler fittings, automatic controls, forced- or induced-draft fan, insulation, electric wiring, integral piping, and protective housing. Boiler shall be constructed in accordance with ASHRAE-Hdbk SE-SI, Chapter 28, UL 834 and ASME BPVC SEC IV. Complete unit shall conform to ASHRAE-Hdbk SE-SI, Chapter 28, UL 834 and MS MIL-B-17452, Class I (standard duty), as modified herein. Heating surface shall be based on a heat transfer of not more than 25,000 British thermal units (Btu) per square foot per hour 80 kilowatt per square meter.

2.4 GAS-BURNING EQUIPMENT

Automatic gas-fired units with input capacities of 400,000 Btu 120 kilowatt per hour or more shall conform to MS MIL-B-18796. Units with input capacities of less than 720,000 Btu per hour 210 kilowatt shall conform to ASHRAE-Hdbk SE-SI, Chapter 28, UL 834 and ANSI Z21.13.

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NOTE: Select atmospheric or mechanical-draft burner as required by the project.

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2.4.1 Atmospheric Gas Burners

Gas burners shall conform to ASHRAE-Hdbk SE-SI, Chapter 28, UL 834 and ANSI Z21.13. Gas burners shall be made of gray cast iron or of an equally serviceable metal approved by the Contracting Officer. Gas burners shall be of the Bunsen type, the venturi type with raised, drilled ports, or the ribbon type of corrosion-resisting metal in cast-iron body, designed to operate without backfiring.

2.4.2 Mechanical-Draft Gas Burner Unit

Burner shall be designed for horizontal installation and firing and shall conform to MS MIL-B-18796. Burner unit shall consist of a complete fuel system, flame safeguard controls, boiler limit and fuel safety interlocks, combustion controls, fan units, and other accessories and components necessary for safe and efficient operation.

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NOTE: Select one of the following two paragraphs.

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2.4.2.1 Forced-Draft Fan Unit

Forced-draft fan shall be an electric motor direct-driven, damper-controlled, centrifugal or axial-flow type unit. Unit shall have sufficient air capacity for complete combustion of the maximum fuel quantity to be burned at maximum firing ratio plus 15 percent excess volume against a 32-percent static pressure overload. Unit shall be constructed and rated in accordance with ASHRAE 51 ASHRAE-Hdbk SE-SI, Chapter 18. Adequate adjustments shall be included in the fan selection or design for maximum burner and boiler pressure drop, combustion air, and plant elevation above sea level.

2.4.2.2 Induced-Draft Fan Unit

Fans shall be designed especially for induced-draft service, and the capacity specified shall be properly increased to compensate for the

elevation above sea level at the point of installation, and shall be based on a flue-gas temperature of 550 degrees F 288 degrees C. All parts of the fan in contact with the flue gases shall be designed to withstand the corrosive effects of the smoke, gases, and fly ash as well as flue-gas temperature up to 600 degrees F 316 degrees C. Fan bearings shall be designed to overcome and prevent bearing overheating, and shall have provisions for lubrication. Water-cooled bearings or air-cooled factory-sealed bearings shall be furnished if recommended by the fan manufacturer. Clean-out and inspection doors shall be provided in each fan housing.

2.5 BOILER TRIM AND ACCESSORIES

2.5.1 Gas-Pressure Regulating Valve

Valve shall be of the automatic type and of the required capacity, shall be adjusted for an outlet pressure of approximately 4 inches of water 1000 pascal for natural gas or 2-1/2 inches of water 620 pascal for manufactured gas, and shall be installed in the connection to the gas boiler. Valve shall be selected from CSA Directory.

2.5.2 Gas-Control Valves

Gas burner shall be supplied with an electric gas-control valve. Gas-control valve shall be positive in action; shall operate with a minimum of noise; and shall render satisfactory service with a 10-percent voltage fluctuation. Valve shall be designed to close immediately upon current failure and to remain closed until the current is restored. Manual control valves shall also be provided in the main line to the burner and in the pilot line. Automatic valves shall be selected from those listed in CSA Directory.

2.5.3 Pressure Gage and Thermometer

Combination pressure gage and thermometer with adequate pressure and temperature ranges shall be installed on each boiler.

2.5.4 Pressure-Relief Valves

Each boiler shall be provided with one or more relief valves constructed and installed in strict accordance with ASHRAE-Hdbk SE-SI, Chapter 27, UL 834 and ASME BPVC SEC IV. Aggregate-relieving capacity of the relief valve shall be not less than that required by ASHRAE-Hdbk SE-SI, Chapter 27, UL 834 and ASME BPVC SEC IV. Relief valves shall be ASME rated and stamped.

2.6 COMBUSTION SAFETY CONTROLS

2.6.1 Atmospheric Burners

A flame-failure, safety-control system of the electronic type incorporating a flame rod shall be provided. Ignition of electronically supervised pilots shall be accomplished with a start-stop station where manual depression of the start button will energize only the pilot valve and ignition transformer. On proof of pilot flame, the main gas valve shall cycle on demand of the controller. Upon failure of main and pilot flame, all fuel valves shall be deenergized and an alarm shall sound within 2 to 4 seconds. System design shall require a manual restart. Pilot shall be supervised during the off-cycle of the main burner and the pilot valve shall close and sound an alarm if any electronically supervised pilot is

extinguished.

Components of the system shall consist of, but shall not be limited to, a flame sensing device, electronic relay, pilots, disconnect switch, wiring, pressure regulators, interlocks, gas control valves, and pilot gas control valve.

2.6.2 Mechanical-Draft Burners

A complete, fully automatic flame-failure, safety-control system of the electronic type, including a prewired and factory-tested programming assembly, shall be provided. Controls shall conform to the requirements of MS MIL-B-18796 except as modified herein. Control shall be of the fail-safe design where component failure within the control or the presence of actual or simulated flame prior to startup will prevent burner operation. Flame-failure control shall be readily removable from the chassis for servicing without disconnecting any wiring. Necessary devices for automatic starting and programming of the pilot and main-burner equipment shall be furnished. Flame-failure sensing device shall be of the flame-frequency, ultraviolet-detector, or flame-rectification type operating in conjunction with an electronic relay. Relay shall open the circuit to the fuel valves in not more than 4 seconds if main-burner flame is not properly established or upon flame failure and shall also actuate an alarm.

Controls shall create a safety shutdown prior to energization of the main fuel valve if the pilot flame is not ignited and detected by the sensing device.

This pilot-proving period shall be limited to 10 to 15 seconds. Trial for main fuel ignition shall be limited to 15 seconds, and repurging the boiler of all combustion gases by at least four air changes shall be mandatory if ignition does not occur during the 15-second period. Control shall recycle automatically after a limit or operating control opens or after an electrical failure. A safety shutdown due to flame failure shall require manual reset of safeguard controls before operation can be resumed and shall prevent recycling of the burner equipment. A low-fire start shall be provided on high-low-type burner controls.

Components of the system shall include a motor starter, disconnect switch, electronic flame relay, alarm, relays, indicating lights, flame-sensing device, wiring, control cabinet, damper for draft control, gas-shutoff safety valve, fan interlocks, airflow switches, and gas-pressure controls.

2.7 COMBUSTION CONTROLS

Combustion-control system shall be automatic and shall be installed in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the manufacturer. Combustion controls shall conform to applicable requirements of MS MIL-B-18796, except as revised herein. Upon completion of the installation, the Contracting Officer shall be furnished with a written statement from the manufacturer's representative certifying that the combustion-control equipment has been installed in accordance with manufacturer's instructions and operates in accordance with specifications.

2.7.1 Three-Position Types

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NOTE: Retain the following for boilers with capacities from 2,000,000 to 5,000,000 Btu per hour 550 to 1500 kilowatt of power.

Combustion-control equipment shall consist of water-temperature and burner controls, draft controls, and necessary accessories. Controls shall position the air and fuel supply for low fire, high fire, and off as required to maintain the desired water temperature within 5 percent. The furnace draft regulator shall control the position of the boiler-outlet damper through a power cylinder so as to maintain the desired furnace draft within 0.01 inch of water column 2.5 pascal. A low-fire interlock to ensure low-fire start shall be provided.

2.7.2 Fixed-Rate, On-Off Controls

NOTE: Retain the following for boilers with capacities from 720,000 to 2,000,000 Btu per hour 200 to 550 kilowatt of power.

Combustion-control equipment shall consist of water-temperature and burner controls, draft controls, and necessary accessories. Temperature-, fuel-, and air-control devices shall be of the two-position type, operating to open or close the fuel valve and air dampers when the water temperature drops below or rises above the predetermined operating temperature. The on-off cycling of the burner by the programming circuit operating switch, with the fuel controls set for optimum fixed-rate firing, shall constitute the method of control. Fixed-rate control shall be capable of maintaining the preset water temperature. Programming circuit operating switch shall cycle the burner on and off to meet the load demand. Air controls shall be manually adjustable to change the fuel-air ratio when necessitated by firing conditions. Furnace-draft regulator shall control the position of the boiler outlet damper through a power cylinder. Where only a single boiler is connected to a stack, barometric-type dampers shall be used in lieu of a power-operated damper.

2.7.3 On-Off Controls

NOTE: Retain the following for boilers with capacities up to 720,000 Btu per hour 200 kilowatt of power.

Burner controls shall be provided as recommended in ASHRAE-Hdbk SE-SI, Chapter 28, UL 834, ANSI Z21.13 and by CSA Directory.

PART 3 EXECUTION

NOTE: Retain, delete, or modify the following as required.

3.1 INSTALLATION

Boilers and Spare Parts shall be installed in accordance with

manufacturer's recommendations.

Manufacturer's Instructions shall be submitted for boilers showing the manufacturer's recommended method and sequence of installation.

Listing of Product Installation shall be submitted for boiler units showing at least 5 installed units, similar to those proposed, that have been in successful service for a minimum period of 5 years. List shall include purchaser, address of installation, service organization, and date of installation.

3.2 FIELD TESTS

3.2.1 Cast Iron Boilers

Boiler and adjacent piping shall be hydrostatically tested and proven tight under a pressure of 45 pounds per square inch gage 310 kilopascal for 24 hours. Submit hydrostatic test reports.

3.2.2 Steel Boilers

Boiler and adjacent piping shall be hydrostatically tested and proven tight under a pressure 1.5 times the maximum rated working pressure for a period of 24 hours with no leakage before the jacket and accessories are added. Leak tests shall be approved by the Contracting Officer prior to adding jackets and accessories on field-erected boilers.

3.3 CLEANING OF BOILER

After the hydrostatic tests have been made and prior to the operating tests, the boiler and connected piping shall be thoroughly cleaned by filling the system with a solution consisting of 3 pounds 1.4 kilogram of trisodium phosphate per 100 gallons 380 liter of water. Water shall be heated to approximately 150 degrees F 66 degrees C and the solution circulated in system for a period of 48 hours; the system shall then be drained and thoroughly flushed with fresh water. Contractor shall be responsible for disposal of contaminated water in accordance with instructions received from Environmental Authority having jurisdiction through the Contracting Officer and in accordance with all Local, State and Federal Regulations.

3.4 FINAL ACCEPTANCE

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NOTE: Following a minimum of 90 calendar days operation (or installation), but no later than one year, the Systems Engineer/Condition Monitoring Office/Predictive Testing Group should inspect the installation using advanced monitoring technologies such as Infrared Imaging or Ultrasonic detection. These technologies can identify insulation voids, insulation settling, and liquid/steam leaks. The Systems Engineer/Condition Monitoring Office/Predictive Testing Group needs to know the warranty expiration date, if there is a warranty, in order to perform the inspections within the prescribed time frame.

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Prior to acceptance of the installation, the heating system shall be subjected to operating tests to demonstrate satisfactory functional and operating efficiency.

Operating test shall cover a period of 24 hours. A report of the test shall be supplied and shall include the following specific information, together with conclusions as to the adequacy of the system: time, date, and duration of test; outside and inside dry-bulb temperatures; water pressure at boiler; water-supply temperature leaving boiler; water-return temperature from system at boiler inlet; boiler make, type, and serial number; design pressure and rated capacity; gas-burner make, model, and rated capacity; gas pressure at burner; flue-gas temperature at boiler outlet; percent carbon dioxide in flue gas; type and calorific value of gas; quantity of water circulated; and surface temperature of boiler jacket.

All indicating instruments shall be read at half-hour intervals, unless otherwise directed. Contractor shall furnish all instruments, test equipment, and test personnel required for the tests; the Government will supply the necessary fuel, water, and electricity.

Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.5 OPERATION AND MAINTENANCE

Contractor shall submit [6] [_____] copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the boiler systems. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

-- End of Section --